ENGLISH TRANSLATION OF PCT/EP2005/003399 SPECIFICATION, CLAIMS, ABSTRACT, 6 SHEETS OF 6 FIGURES AND COVER PAGE (18 pages)

SOLID-WALL CENTRIFUGE COMPRISING A WEIR PROVIDED WITH A STATIONARY DEFLECTOR PLATE

[0001] The invention relates to a solid-bowl centrifuge according to the preamble of Claim 1.

[0002] A solid-bowl centrifuge of the above-mentioned type is known from European Patent Document EP 0 702 599 B1 and U.S. Patent Document US 5,593,377 respectively. These two documents disclose a solid-bowl screw-type centrifuge with a drum, having a weir which is provided with a passage for draining a liquid phase separated in the centrifugal drum, a throttle disk (orifice plate? Transl.) being assigned to the passage, which orifice plate is constructed as a non-rotating part whose distance to the passage is variable, so that an adjustment of the liquid level in the centrifugal drum becomes possible by an axial adjustment of the orifice plate.

[0003] The stationary orifice plate has no disadvantageous effect on the method of operation of the centrifugal drum. In particular, there is no disadvantageous braking effect as a result of the liquid passing through the annular gap between the rotating weir and the stationary liquid plate.

[0004] The annular gap generates a flow resistance which is the greater, the shorter the axial distance between the weir and the orifice plate. However, as the flow resistance increases, a greater fluid pressure is required at the passage, which leads to a rise of the liquid level in the centrifugal drum. When the axial distance between the weir and the orifice plate is enlarged, the liquid level in the centrifugal drum will fall to a value caused by the passage of the weir without such an orifice plate.

[0005] This solution has been very successful in practice because it can be implemented in a simple and cost-effective manner by the further development as a construction which is stationary during the operation and does not rotate along with the drum without the necessity of transmitting adjusting forces to co-rotating parts of the centrifuge, and thereby advantageously makes it possible to excellently control and/or regulate the separation or clarification operation in the drum.

[0006] From International Patent Document WO 01/85349 A1, it is known (Figure 3) to implement the axial adjustability of an orifice plate, which does not rotate along and whose method of operation corresponds to that of European Patent Document EP 0 702 599 B1, between the passage openings of the drum and the orifice plate in that

the orifice plate can be swiveled in a flap-type manner about a pivot bearing at its outer circumference by means of an actuator. By means of a ring groove, which is called a "ring cup" there, the flow conditions at the passage are to be optimized. Figure 1 of this document also describes a variant in which a type of cylindrical ring having a wall, which is oriented parallel to the axis of rotation of the drum, is arranged in the annular gap between a stationary housing wall and the centrifuge lid, adjustable apertures, through which the drained liquid sprays directly radially to the outside, being arranged in this ring.

[0007] German Patent Document DE PS 966 080 shows a solid-bowl screw-type centrifuge whose liquid discharge from the drum is oriented radially to the outside, where the liquid is collected in a type of annulus having an almost circular cross-section. German Patent Document DE PS 706 968 also shows liquid discharges directed radially to the outside from the drum.

[0008] German Patent Document DE 25 15 452 also shows a plate behind the axially oriented liquid discharges, which plate rotates along with the drum and deflects the discharging liquid virtually by 180° into the opposite axial direction.

[0009] US Patent Document US 20 83 899 shows a centrifuge with a vertical axis of rotation without an orifice plate.

[00010] French Patent Documents FR 20 57 600 and FR 20 54 722 each show solid-bowl screw-type centrifuges with a fluid discharge directed axially with respect to the axis of rotation, where emerging liquid can spray from a wall behind the outlets back again to the drum.

[00011] In contrast to the state of the art according to the above-mentioned type, as it is known from European Patent Document EP 0 702 599 B1, it is an object of the invention to implement a more careful discharge of the liquid phase from the weir in a simple manner.

[00012] The invention solves this task by the object of Claim 1.

[00013] Accordingly, a deflector plate, which is stationary during the operation, that is, does not rotate along with the drum, is arranged in front of the drum lid outside the centrifugal drum – inside the collecting chamber -, which deflector plate extends away from the drum lid, widens at least in sections and has at least one interior jacket, the distance of the interior jacket from the axis of rotation not being constant, but widening or enlarging.

[00014] "Widening" means that the deflector plate is no plane plate but a "sleeve-type" component with an inside diameter which changes – here, which is enlarged – at least over a portion of the axial dimension or the entire axial dimension. The deflector plate therefore has a defined axial dimension (as an extension of the axis of rotation of the drum) as well as an interior and exterior jacket, the distance of the interior jacket from the axis of rotation not being constant but being widened or enlarged.

[00015] The widening deflector plate preferably has an opening angle γ with respect to a plane extending perpendicularly to the axis of rotation D of the drum or parallel to the drum lid, which opening angle γ is greater than 0° and smaller than 90°. The widening deflector plate at the interior jacket therefore has an angle of 90° -γ with respect to the axis of rotation (D) of the drum, which is greater than 0° and smaller than 90°.

[00016] The deflector plate preferably has such a shape or is arranged or integrated in the arrangement such that the liquid first exits axially to the outside from the drum until it impacts on a wall or plate from which it sprays essentially radially to the outside, the liquid arriving on the widening deflector plate which prevents the exiting liquid from directly radially impacting on a wall or walls – particularly walls oriented parallel to the axis of rotation – of the collecting chamber, so that the development of noise is reduced in comparison to an arrangement without a deflector plate.

[00017] The liquid first exits axially – that is, parallel to the axis of rotation of the drum – from the drum to the outside until it impacts on a wall by which it is directed essentially radially to the outside. Here, it impacts on the widening deflector plate which prevents the exiting liquid from arriving at the drum again.

[00018] The widening geometry of the deflector plate has several advantages. On the one hand, it permits a clear reduction of the operating noise of the centrifuge because the liquid sprays no longer directly from the annular gap particularly between the orifice plate or another component and the drum lid against walls of the collecting chamber but is deflected by an angle which corresponds to the opening angle of the deflector plate. As a result, the liquid no longer arrives perpendicularly on the housing walls of the collecting chamber which clearly reduces the development of noise. In view of the high number of revolutions of, for example, 3,500 r.p.m., this is a significant advantage in practice.

[00019] In addition, because of the "softer" impacting of a liquid jet on the walls of the collecting chamber, the foam formation is reduced in the case of products with a tendency to foam.

[00020] Another advantage is a reduction of the power consumption by the initially fast drainage from the interior area, particularly away from the centrifugal drum surface.

[00021] In particular, an annular gap is formed between the passage and an orifice plate outside the centrifugal drum or between the passage and another component, which annular gap guides the liquid radially to the outside and which is preferably completely or partially surrounded by the widening deflector plate over its axial dimension, so that the direct radial spraying of the liquid phase out of this annular gap is prevented. Specifically here, the deflector plate has an advantageous effect because it prevents that the exiting liquid again impacts on the drum.

[00022] The inside diameter of the deflector plate preferably is larger than the outside diameter on which the passage openings of the centrifugal drum are arranged.

[00023] Preferably, the deflector plate axially directly adjoins the passage openings, so that a flowing-out of liquid between the drum lid and the deflector plate is prevented. In another advantageous variant, projections – sleeves or the like –, which axially overlap the deflector plate, are provided at the passage openings.

[00024] All other initially described advantages of the respective state of the art are maintained.

[00025] In particular, the deflector plate has a ring-type, conically widening shape.

[00026] The opening angle of the interior jacket of the deflector plate preferably amounts to between 5 and 45°, particularly 10 to 30°. Specifically by means of the latter angle range, particularly advantageous results can be achieved, particularly a clear minimizing of noise.

[00027] The opening angle of the deflector plate may be constant or may change over its axial dimension and/or in the circumferential direction.

[00028] A multipart, particularly two-part construction of the deflector plate is also conceivable in order to implement its widening shape in a simple manner.

[00029] Advantageous further developments are contained in the subclaims.

[00030] In the following, the invention will be described by means of embodiments with reference to the drawing.

[00031] Figure 1 is a sectional view of the axial end region of a solid-bowl centrifuge according to the invention having a deflector plate;

[00032] Figure 2 is an enlarged cut-out of Figure 1 with a simplified representation of the flow conditions in the manner of an example;

[00033] Figure 3 is a sectional view of the axial end region of a second solid-bowl centrifuge according to the invention;

[00034] Figure 4 is an enlarged cut-out of Figure 3 with a simplified representation of the flow conditions in the manner of an example;

[00035] Figure 5 is a sectional view of the axial end region of a third solid-bowl centrifuge according to the invention of Figure 3 with an alternative manner of fastening the deflector plate; and

[00036] Figure 6 is a sectional view of the axial end region of a third solid-bowl centrifuge according to the invention of Figure 3 with another alternative manner of fastening the deflector plate.

[00037] Figure 1 illustrates a solid-bowl centrifuge having a rotatable centrifugal drum 1 with a horizontal axis of rotation, which solid-bowl centrifuge is constructed as a solid-bowl screw-type centrifuge. A rotatable screw 2 is also arranged in the centrifugal drum 1, a differential rotational speed generally being maintained between the centrifugal drum 1 and the screw 2 during the operation.

[00038] The centrifugal drum 1 is closed by an axial drum lid 3 which is equipped with at least one weir 4 – fixed or adjustable by means of shutters 13 – for draining a liquid phase from the centrifugal drum.

[00039] The weir 4 comprises a passage with at least one or more passage openings 5 in the drum lid as well as with an orifice plate 6 arranged outside the centrifugal drum 3 in front of the passage openings 5, which orifice plate 6 is constructed as a part which does not rotate along during the operation and whose distance from the passage openings 5 is variable. Here, a collar-type projection 19 of the weir protrudes axially from the drum lid 3. This can be implemented, for example, by means of sleeves in/at the passage openings 5 or by means of a ring or a second shutter of a different diameter.

[00040] The changing of the axial distance between the passage openings 5 and the orifice plate 6 can take place, for example, by an axial movement by displacing or swiveling the orifice plate 6 in front of the passage openings 5, for example, by means

of actuators. To this extent, the construction in principle corresponds to the state of the art of the above-mentioned type.

[00041] In contrast to the state of the art, a deflector plate (or "deflector sleeve") 12 of a ring-type construction is assigned to the orifice plate 6, which deflector plate 12 here has a particularly advantageous conical shape, the deflector plate 12 preferably covering the ring gap 8 preferably over its entire length and widening away from the passage openings 5.

[00042] The opening angle γ of the interior jacket 7 of the deflector plate 12 – see Figure 2 – relative to the perpendicular line with respect to the axis of rotation D of the drum or with respect to a plane E extending parallel to the drum lid, preferably amounts to between 5 and 45°, particularly between 10° and 30°.

[00043] Preferably, the opening angle γ is constant over the entire radial and axial dimension of the deflector plate 12. However, it may also change suddenly or continuously, for example, at a bend from 15 to 20°.

[00044] Since the liquid flowing out of the annular gap 8 to the outside places itself against the deflector plate 12 and is deflected by the latter, it essentially impacts at an angle γ smaller than 90° on the walls 9, 10 of a collecting chamber 11 surrounding the orifice plate, for draining the liquid. This also results in a clear reduction of noise during the operation.

[00045] Especially a multipart, particularly a two-part construction of the deflector plate 12 is also conceivable in order to constructively implement the widening shape of the deflector plate 12 in a simple manner.

[00046] The optimized flow conditions are illustrated in Figure 2.

[00047] Especially the optimized drainage from the annular gap 8 is particularly easily visible while avoiding a direct flowing-out of the liquid phase L in the radial direction. The liquid therefore no longer impacts on the wall 9 of the collecting chamber which extends essentially parallel to the axis of rotation. The noise development is thereby clearly reduced, which is a clear advantage in view of the preferred – but not exclusive - usage range at drum diameters of far more than 500 mm. Noise limit values are more easily observed or reach only at higher rotational speeds. Power losses are also avoided if the liquid no longer impacts on the drum or the bearing hub after having exited the latter.

[00048] In particular, the opening angle is selected such that the wall 9 on the outside on the collecting chamber 11 is not reached directly by the exiting product jet.

[00049] A spiral casing geometry of the deflector plate 12 similar to the spiral casing of centrifugal pumps is conceivable (not shown here).

[00050] According to Figure 3, the weir comprises the passage openings 5 in the drum lid 3 but no orifice plate 6. On the contrary, the liquid flows directly against another component – here, a ring plate 14 in front of or on a transmission housing 18 – which is constructed as a part which does not rotate along during the operation. The annular gap 8', which is partially covered here toward the outside by the deflector plate 12, is constructed between the drum lid 3 and the additional ring plate component 14.

[00051] Here, the flow conditions are optimized (see Figure 4) in a manner similar to Figure 2. The deflector plate 12 may also have a dimension which is larger than illustrated in the figures relative to the axial length of the annular gap 8'.

[00052] The fastening of the deflector plate 12 preferably advantageously made of metal plate or plates can take place in different fashions; thus, by way of bolts 15 or 16 in an axial (Figure 1 and 3) or radial (Figure 4) orientation, which extend from surrounding walls 9 or 10 to the deflector plate, or by means of a particularly advantageous stabilizing plane ring 17 between the exterior jacket of the deflector plate 12 and the wall 9 (Figure 6).

[00053] The arrangement of the fastening bolts or of the fastening ring 17 in the radial direction reduces the risk of its erosion because it is arranged virtually in (behind? translator) the turbulent region of the deflector plate 12. The number of fastening bolts is variable and, as a rule, will amount to at least three.

[00054] Reference Numbers:

Centrifugal drum	1
Screw	2
Drum lid	3
Weir	4
Passage opening	5
Orifice	6
Interior jacket	7
Annular gap	8, 8'
Walls	9, 10
Collecting chamber	11
Deflector plate	12
Weir	13
Ring plate	14
Bolt	15, 16
Ring	17
Transmission housing	18
Projection	19